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(54) PRODUCTION OF FOILS

(71) We, BRITISH INDUSTRIAL PLASTICS LIMITED, a Company organised under the laws of Great Britain, of 77 Fountain Street, Manchester M2 2EA, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the production of foils.

The application of a pattern, whether decorative or merely utilitarian (e.g. literary), to articles moulded from thermosetting synthetic resin moulding compositions, for example urea- or melamine-formaldehyde-based moulding compositions, commonly involves applying and bonding to the part-cured moulding a patterned sheet of paper or other suitable material which has been impregnated with a synthetic thermosetting resin. Such impregnated sheets are commonly known as "foils", and they are bonded to the part-cured moulding by the application of heat and pressure, which first softens the impregnating synthetic resin so that it flows and contacts the surface of the part-cured moulded article, and subsequently brings about complete cure of the synthetic resin, whereby it becomes insoluble and hard, and bonds the foil to the moulding. Foils are also used in the manufacture of laminates, wherein they form the surface sheets.

Various methods have been suggested for the preparation of foils. They have been made by a wet process, in which the synthetic resin, in the form of a viscous liquid, is contained in a bath; the sheets to be impregnated are dipped into the synthetic resin and then dried. This method has the obvious disadvantage that drying of the foils is a time- and space-consuming operation. An alternative method which has been suggested in British Patent Specification No. 1,076,011 is to pass the sheet under a distributor from which a stream of dry powdered synthetic resin is allowed to fall more or less evenly over the surface of the sheet, after which the synthetic resin is heated to cause it to adhere to the sheet.

According to the present invention a method for producing a foil as hereinbefore defined comprises establishing an electrostatic field between a spray gun and a sheet of paper or similar material in contact with an earthed metal plate, supplying to the spray gun a synthetic resinous material comprising a synthetic thermosetting amino-formaldehyde resin and a curing catalyst, whereby the synthetic resinous material is electrically charged and is conveyed under the influence of the electrostatic field onto the sheet, and subjecting the thus treated sheet to conditions of elevated temperature and optionally of elevated pressure to cause the synthetic resinous material to adhere to or at least partially to impregnate the sheet without effecting complete cure of the resin, so that the synthetic thermosetting amino-formaldehyde resin in the foil thus produced is capable of being completely cured in a subsequent process.

For convenience, the terms "synthetic resinous material" and "synthetic thermosetting amino-formaldehyde resin" will be referred to in the following description as "resinous material" and "resin", respectively.

The basic principle and theory behind electrostatic deposition are well known, and will not be discussed here.

An advantage we have found when using this technique is that, if powdered resin is used, handling of the sheet subsequent to the application of the resin is facilitated since the resin is attracted to the sheet and is not dislodged from it merely by its being moved; even though some of the resin may fall from the sheet, a layer will be retained. There is also the advantage that substantially even coating may be obtained, since should there be a temporary uneven build-up of resin, material subsequently deposited will gener-

[*Price 25p*]

ally be attracted to the less heavily coated areas of the sheet.

The method is applicable to the use of both solid resin and curing catalyst and resin and curing catalyst in solution, although generally we prefer to use solid powdered resin and curing catalyst. The resin and curing catalyst are dispersed in a finely particulate form and a charge is then applied to the particles, as mentioned, by means of an electrostatic spray gun; the charged particles are then attracted towards the target. We have obtained attraction of the particles to paper and similar thin flexible sheet material by holding it against an earthed metal plate. When the resin and curing catalyst are in solution, the voltage applied to it by means of the spray gun has the combined effect of hydrostatically atomising the solution and electrically charging the atomised resin and curing catalyst.

The term "paper or similar material" is intended to embrace other materials or fabrics which are suitable for use in the production of foils. Thus, the term includes other materials, such as textile and non-woven materials, having absorptive properties such that, when the foil is being used to surface an article, the resin, when it melts, is able to penetrate the foil and to contact the surface of the article being moulded. We have used normal alpha-cellulose paper of weight about 45 gm./sq.m. but other types, for example heavier paper, or papers made from or containing artificial fibres, e.g. rayon, may be employed; as also may thin fabrics having suitable properties of absorbency or heat stability.

The process may be carried out discontinuously, i.e. separate sheets of material being treated individually, or the process may be continuous, for example the sheet material may be fed continuously past the electrostatic gun, the sheet, during its passage past the gun, being pressed firmly against a suitably conductive earthed backing. The word "sheet" in this specification refers both to separate pieces of sheet material and to continuous sheets, for example rolls of material.

After deposition of the resinous material on the sheet (and after drying if necessary, as when a solution has been sprayed) the resin may be caused to adhere to the sheet simply by heating the resin to a temperature sufficiently high to cause some softening of the resin and consequent adhesion without completely curing the resin. The application of pressure facilitates adhesion and, if desired, impregnation of the sheet. Of course it may be sufficient merely to bring about adhesion and cohesion of the layer of resin on the sheet, impregnation occurring subsequently, for example at the time of application of the foil to the part-cured moulding. When impregnation of the sheet is desired, we have, as mentioned above, found it advantageous to apply pressure to the coated sheet. This may be done either by putting the sheet between heated flat platens for a sufficient dwell time, or by passing it, with or without preliminary heating to induce some softening of the resin, between suitably heated rolls.

The usual considerations of foil production apply in this process as in prior processes, and the particular difficulties to be avoided, for example avoidance of ink-running in the pattern, are well-known to the man skilled in the art.

The resin employed is preferably a powdered melamine-formaldehyde, optionally together with additives to improve certain characteristics of the material. Thus, it may be of advantage to employ condensation products of formaldehyde with a guanamine derivative, for example benzoguanamine, acetoguanamine or 2-cyclohexyl-4,6-diamino-s-triazine. Resins which are particularly suitable for use in accordance with the invention are those melamine-formaldehyde resins which have a melamine: formaldehyde ratio of 1:1.3 to 1:1.7. The resinous material also contains a curing catalyst, e.g. magnesium chloride, and suitably also a plasticiser, e.g. dimethylolethylene-urea. We have found that a resin spray-dried from a solution of "Beetle" BL35 (a melamine-formaldehyde resin of M:F ratio 1:1.5) containing 10% dimethylolethylene-urea and 0.2% magnesium chloride (both based on the weight of resin solids) is particularly suitable, and such a material leads to foils eminently suitable for placing onto part-cured mouldings and then effecting final cure. ("Beetle" is a Registered Trade Mark). When the foil is intended ultimately to be used as the surfacing sheet of a laminate, the resin may be one having a higher formaldehyde:melamine ratio, e.g. 2:1 or greater.

As is known, the voltage of the power supply to the spray gun must be high enough (a) to charge the particles of resinous material, and (b) to establish the electrostatic field. We have found a power supply of 90,000 volts to be effective, but this of course may be varied, depending on other factors.

The invention will be described by way of example with reference to the accompanying schematic drawing, which illustrates three typical preparative routes that may be followed according to the invention.

The sheet which will eventually constitute the base for the foil is an alpha-cellulose sheet (45 gm/sq.m.; 0.1 mm thick). The sheet (1) is clipped to an earthed metal backing plate (2), which is set up in the vertical plane (this is preferred because ex-

cess powder tends to fall away from the sheet, but the disposition of the sheet is not very important; thus it may be horizontal, either above or below the gun). The electrostatic spray gun (3) is run at 90,000 volts (this, of course, may be varied) and substantially dry powdered melamine-formaldehyde resin (4) is fed to the gun and is directed on to the sheet surface to be coated.

After coating to a desired resin thickness, the sheet may be treated in several different ways, three of which are illustrated. It may simply be heated by radiant heat—route A—from a suitable heater (5) to cause the resin to adhere to and impregnate the sheet to some degree. It may be pressed between heated platens (6)—route B—(we have used a temperature of 100°C. with 100 p.s.i. for 5 minutes) to obtain impregnation, or it may be passed between rolls (7) either preceded by heating—route C—or rolls of a sufficiently high temperature to produce the desired flow may be used without prior heating.

After preparation the foil may be trimmed, cooled and stored, or it may be used immediately in a moulding press, for example in the application of a decorative surface to the interior of a cereal bowl.

WHAT WE CLAIM IS:—

1. A method for producing a foil as hereinbefore defined, comprising establishing an electrostatic field between a spray gun and a sheet of paper or similar material in contact with an earthed metal plate, supplying to the spray gun a synthetic resinous material comprising a synthetic thermosetting amino-formaldehyde resin and a curing catalyst, whereby the synthetic resinous material is electrically charged and is conveyed under the influence of the electrostatic field onto the sheet, and subjecting the thus treated sheet to conditions of elevated temperature and optionally of elevated pressure to cause the synthetic resinous material to adhere to or at least partially to impregnate the sheet without effecting complete cure of the resin, so that the synthetic thermosetting amino-formaldehyde resin in the foil thus produced is capable of being completely cured in a subsequent process.

2. A method as claimed in claim 1 wherein the synthetic thermosetting amino-formaldehyde resin comprises a melamine-formaldehyde resin.

3. A method as claimed in claim 2 wherein the melamine-formaldehyde resin has a melamine: formaldehyde ratio of from 1:1.3 to 1:1.7.

4. A method as claimed in claim 2 or claim 3 wherein the curing catalyst comprises magnesium chloride in an amount sufficient to catalyse the cure of the melamine-formaldehyde resin.

5. A method as claimed in any of claims 2 to 4, wherein the synthetic resinous material includes dimethylol-ethylene-urea.

6. A method as claimed in any of claims 1 to 5 wherein the synthetic thermosetting amino-formaldehyde resin comprises a formaldehyde-guanamine condensation product.

7. A method as claimed in any of claims 1 to 6 wherein the electrostatic field is produced by a power supply of about 90,000 volts.

8. A method as claimed in any of claims 1 to 7 wherein said sheet is a continuous sheet and is conveyed continuously through said electrostatic field.

9. A method for producing a foil, substantially as hereinbefore described with reference to the accompanying drawing.

10. A foil, whenever produced by a method as claimed in any of claims 1 to 9.

11. An article moulded from thermosetting resinous moulding material, having a decorative surface produced from a foil as claimed in claim 10.

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1285551 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*